



**EuroGOOS**  
European Global Ocean  
Observing System

**EuroGOOS Tide Gauge Task Team**

La Rochelle, 3-4 November 2016

*International Workshop on Sea-Level Measurement Technologies*

*4 November 2016, University of La Rochelle, France*

The EuroGOOS Tide Gauge Task Team held on November 4<sup>th</sup> 2016 an International Workshop on Sea-Level Measurement Technologies at the University of La Rochelle (France). Its main objective was to recover a platform for the communication and exchange of experiences between the operational and scientific/user sea level communities in the region, by discussing issues like inter-comparison of sea level sensors, emerging technologies, status of existing national networks, data processing and quality control. There were 12 oral presentations and a poster session.

**Attendants:**

- LEGOS, France: Laurent Testut, Etienne Poirier
- SHOM, France: Vincent Donato, Séverine Enet
- Puertos del Estado, Spain: Begoña Pérez Gómez, Irene Pérez González
- CNR-ISMAR, Italy: Fabio Raicich
- SMHI, Sweden: Thomas Hammarklint
- BODC, UK: Elizabeth Bradshaw
- NOC, UK: Andy Mathews
- BSH, Germany: Anna Gyldenfeldt
- FMI, Finland: Katri Leinonen
- JRC (ISPRA), Italy: Alessandro Anunziato
- SONEL, University of La Rochelle, France: Guy Woppelmann, Médéric Gravelle, Etienne Poirier, Elizabeth Prouteau
- UIB-IMEDEA, Spain: Marta Marcos
- DMI, Denmark: Per Knudsen
- MSI, Tallinn University of Technology, Estonia: Tarmo Köuts, Kaimo Vahter
- Hellenic National Tsunami Warning Center, NOA, Greece: Spyros Liakopoulos
- Kartvertket, Norway: Hilde Sande Barck

**Minutes:**

Several speakers described the status of existing tide gauge networks in different countries: in Spain, new developments have now started for 2Hz data processing and characterization of high frequency sea level oscillations such as *meteotsunamis*, *infragravity* or even tsunami waves. In Germany, the Federal Waterways and Shipping Administration (WSV) operate and

maintain hundreds of stations in coastal and inland waters that transmit 1-min data in near-real time to Pegel Online data portal. Between 2009 and 2015, 724 of these tide gauges have been modernized in accordance with the “Manual on Modern Gauges”, mainly with radar and pressure sensors. The Swedish Sea Level Network is composed by 23 stations, and 3 mobile stations, the older in operation since 1889 (Stockholm). They use float gauges in stilling wells that were modernized in 2005 (paper charts still used as backup). An interesting test site is in operation at Onsala Space Laboratory, with well established geodetic infrastructure, for testing up-down GPS, radar and bubbler gauges (including transmission of 1-min data to NEAMTWS). In Finland, the FMI runs 14 float gauges in stilling wells. The data processing and quality control is being upgraded to deal automatically with 1-min resolution sampling data. Estonia (MSI-TUT) runs  $15 \pm 3$  stations based on pressure sensors that provide as well local wind waves, water temperature and meteorological parameters. Sea level data are provided in combination with the storm surge forecast for the next 48 hours. SHOM network, in France, is based on 48 radar gauges with 1 min sampling and latency. The data are available also in the Global Telecommunication System (GTS) used by the meteorological agencies. Table 1 displays a summary of the main characteristics of the networks presented in this workshop.

	<b>SPAIN(REDMAR) 36 STATIONS</b>	<b>GERMANY (BSH) 724 STATIONS</b>	<b>SWEDEN (SMHI) 27 STATIONS</b>	<b>FINLAND (FMI) 14 STATIONS</b>	<b>ESTONIA (MSI- TUT) (18 STATIONS)</b>	<b>FRANCE (SHOM) (48 STATIONS)</b>
<b>PARAMETERS</b>	Radar Sea level, wind waves, atm. pressure and wind	Radar/pressure Sea level	Float/stilling well Sea level	Float/stilling well Sea level	Pressure sensors Sea level, water temperature and meteorological data	Radar sensors Sea level, atm. pressure
<b>SAMPLING/LATENCY</b>	1 min / 1min	1 min / 1min	10 min / 1 h	1 min / 1min	5 min / 5 min	1 min/1min
<b>AUTOMATIC QC</b>	Yes		Yes	Yes	No	no
<b>VISUAL QC</b>	Once per week		Once per week	On weekdays		no
<b>TSUNAMI DETECTION ALGORITHM</b>	Yes	No	No	No	No	no
<b>DATA ON THE GTS</b>	No	No	No	No	No	Yes
<b>TEST SITE</b>	No	4 at the North Sea, including sea level and 1D and 2D wave spectra	Onsala Space Laboratory: GPS, radar and bubbler	No	No	Brest with different sensors technologies
<b>ROUTINE IN-SITU VALIDATION</b>	Once per year		Once per week	Once per week		Twice a year
<b>NEW DEVELOPMENTS</b>	2Hz data processing and characterization of high frequency oscillations		New Sea Level Network in cooperation with the Swedish Maritime Administration	1-min resolution automatic QC		Design of new autonomous tide gauge

*Table 1. Characteristics of different national networks presented during the workshop.*

Apart from these general purpose national tide gauge networks, two presentations were focused on the use of tide gauges for tsunami warning. JRC (Joint Research Center, European Commission) has installed, in collaboration with different national agencies, several stations in

the Mediterranean Sea, based on an inexpensive and autonomous radar sensor. The Hellenic National Tsunami Warning Center (NOA, Greece) has installed recently their own 17 radar tide gauges for tsunami warning. They plan to use in the future the conventional tide gauges run by the Hellenic Navy, when they become upgraded in terms of sampling and latency.

Several presentations were focused on experiments and test sites with new technologies for measuring sea level such as the “mobile” and autonomous tide gauge designed by SHOM for campaigns, a video tide gauge being developed by the University of La Rochelle, a new radar gauge designed for operation in polar regions by NOC (UK) or the GPS buoys experiments carried out by JRC and others.

Finally, several presentations were dedicated to problems on data reception and distribution to and from existing data portals, standards on data formats, data processing and sea level products. SHOM representative presented their data base and software for management and quality control “Tide Data Base (TDB)”.

BODC and PSMSL experts illustrated this from the point of view of GLOSS (Global Sea Level Observing System), discussing data exchange semantics, standards and sharing policies. The problems, proposals and conclusions of this presentation are important for the EuroGOOS TGTT, that pretends to become a regional component of GLOSS. The different GLOSS Data Centers were presented, each one focused on specific data sampling and data update frequency: e.g.: PSMSL: monthly averages and annual update, JASL/UHSLC: hourly data and annual update, VLIZ/SLSMF: 1-min and near real time data, etc. Interestingly, near-real time quality control recommendations are the same adopted in CMEMS. However, they found problems on the way the data are being distributed and propose improvements such as:

- identification code for a spatial object instead of an individual platform,
- agreement on definitions (e.g. difference between “station” and “platform”, meaning of “data provider”)
- requirement of detailed metadata including description of bench-marks and history of the tide gauge and datum, data sampling and processing details, instrument information
- use of a DOI (Digital Object Identifier)
- ensure data is stored in a versioned and timestamped manner

The last presentation from Puertos del Estado analyzed the status and main problems found in existing sea level data from tide gauges in the IBI (Iberian-Biscay-Ireland) and Mediterranean regions of CMEMS. The In-Situ Thematic Assembly Centres (INS-TAC) of CMEMS are fully operational in the region since April 2015, and distribute as well sea level data from existing tide gauges in Europe. They provide the data in standard Netcdf format with standard near-real time quality control procedures. From the users point of view, one of the main advantages is the flexibility of data access, enabling both direct one-click data download from the web browser and batch file downloading through ftp indexes. Nevertheless, several issues concerning the tide gauge data storage and distribution must be improved. The INSTAC’s welcome in fact recommendations from the EuroGOOS TGTT, for implementation of current standardization efforts in other programs or projects (GLOSS, AtlantOS, etc), definition of sea level products and standard sampling intervals, etc. One of the most immediate actions

suggested in this presentation was to include data sampling and type (filtered, instantaneous, etc) info into the Netcdf metadata. Besides, an important reorganization is now being done, after discovering the duplication of stations at different INSTAC's and to avoid differences between distributed files. One concern in this sense is the update of the historical time series with datum changes: this will only be possible with an intense communication with the original data owners and providers. From the spatial coverage point of view, it is important to note the scarce amount of stations available in the Mediterranean from Italy eastwards.

These two last presentations underscored the **urgent need of strengthen the collaboration between GLOSS/PSMSL and the EuroGOOS TGTT to provide a list of recommendations to the new CMEMS data portals**, based on what was discussed in this workshop.

### *Side meeting at OST/ST congress: Altimetry and tide gauge for sea level*

*3 November 2016, Espace Encan, La Rochelle, France*

A side meeting on *Altimetry and tide gauge for sea level*, was hosted by the annual OST/ST International congress on Satellite Altimetry, on 3 November 2016, at the Espace Encan of La Rochelle. The meeting, convened by the EuroGOOS Tide Gauge Task Team, had the objective of presenting this task team activities to the altimetry community. Tide gauges and altimetry are the basic technologies used for measuring sea level. Both techniques are needed and complementary and will always require exchange of information and products for validation, and communication between both communities. The session was chaired by Laurent Testut (EuroGOOS TGTT member) and Begoña Pérez Gómez (EuroGOOS TGTT co-chair) and attended by several altimetry experts from the OST/ST congress and by tide gauge experts attending the EuroGOOS TGTT workshop of November 4<sup>th</sup>. It started with two introductory presentations and was followed by an open discussion. Médéric Gravelle (University of La Rochelle) presented an exercise about optimal distribution of tide gauges for calibrating multiple satellite altimetry missions, based on just a geometric approach. Begoña Pérez Gómez presented the objectives, terms of references and activities of the EuroGOOS Tide Gauge Task team, explained the objective of the session and the need of discussion and asked for answers to the question:

*How could the European TG network be improved for altimetry calibration / exploitation in terms of instrumentation, network coverage, data sampling and quality, data availability, co-location (GNSS, met stations, etc)?*

After a first debate on the meaning and objectives of a tide gauge network focused on altimetry calibration, the final consensus was that tide gauge and altimetry data must always be compared, and that coastal and dense tide gauge networks will be needed to validate the quality of altimetry data near the coast. The main concerns of the altimetry community were still the lack of information about vertical land motion at many tide gauge stations, the quality of the tide gauge data (datum or reference changes) and the remaining gaps in the time series. Michaël Ablain (CLS) informed about a proposal on requirements for an appropriate tide gauge

network for global validation of Sentinel missions (Sentinel 3 Validation Team: S3VT, CAL/VAL requirements), and mentions for example the benefits of increasing the number of tide gauge stations (and better chosen locations) in the global validation analysis, to reduce uncorrelated errors.

From the different comments and suggestions received from the audience during the session, we confirm that the altimetry community recognizes the need of tide gauge stations for altimetry validation and interpretation. Based on previous analysis (e.g. the one of S3VT) and the input of this side meeting, we can compile the following list of recommendations from the altimetry community to the tide gauge community:

**List of recommendations from the altimetry community:**

1. *Vertical land movements: they request more co-location of GNSS stations with existing tide gauges to monitor vertical land motion*
2. *Tide gauges are needed in the open ocean for validation of altimetry in ocean circulation studies*
3. *There is a demand also of coastal tide gauges, including estuarine gauges to the extent of the tidal influence, for validation of altimetry near the coast*
4. *Quality controlled time series to minimize undocumented datum or reference changes and clock errors: datum control within a month (or less for near-real time validation in altimetry) and metadata with information about the origin of the error.*
5. *A homogenous product, with standard format (e.g. CF compliant) and a one-click download data bottom is required. Someone also asked for tidal predictions in the data*
6. *Homogeneous sampling: hourly data should always be provided, independently of what other high frequency samplings are available for other applications*
7. *Whenever possible, optimizing the location of stations with respect to altimetry ground-tracks and improving the spatial coverage of the in-situ network*
8. *Redundancy (double or multiple) of sea level sensors would be appreciated for avoiding gaps in the historical tide gauge time series*

The session was closed with the recommendation of the EuroGOOS TGTT being represented in future altimetry meetings for reporting on the status of the in-situ networks and the feasibility of the mentioned requirements for the altimetry users. The EuroGOOS TGTT thanked the OST/ST Congress organization (Pascal Bonnefond) for facilitating the organization of this side meeting and the audience for their comments and participation.